

Temperature Protocols

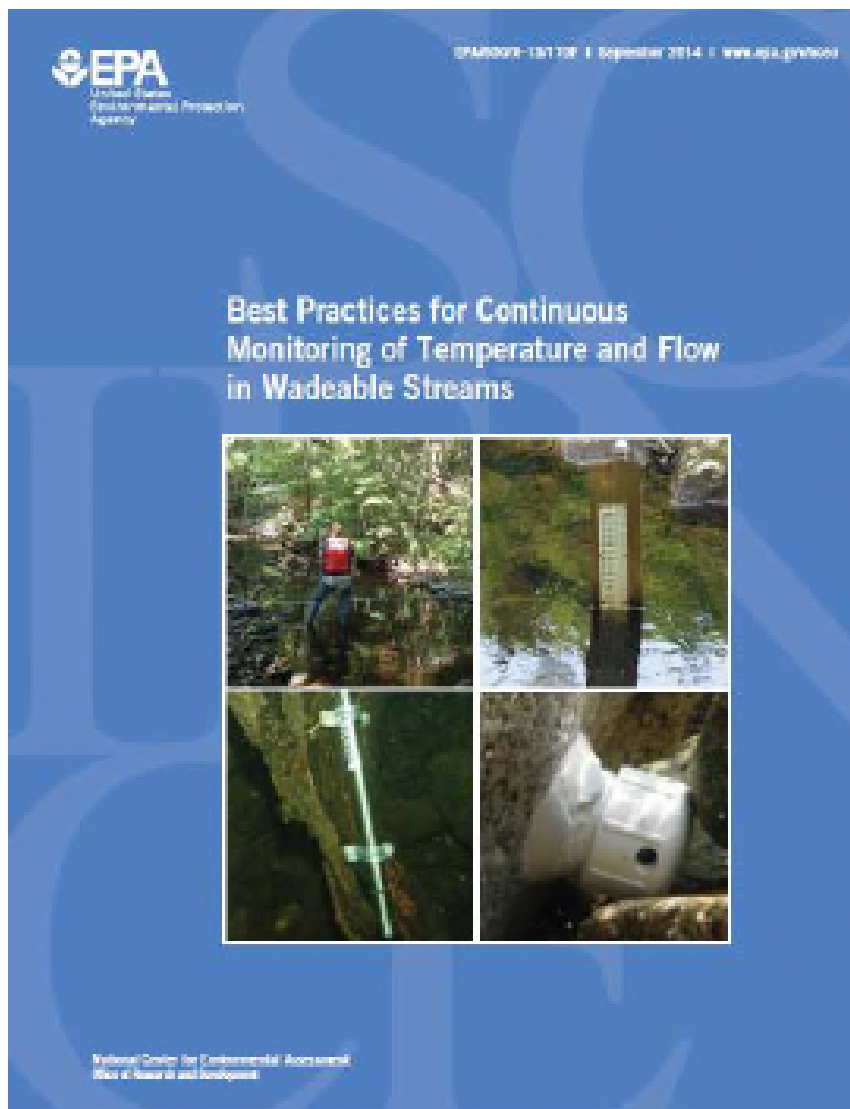


National Water Quality Monitoring Conference
Field Protocols Workshop

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Temperature - outline



- Equipment
- Sensor placement
- Installation techniques

Temperature = the 'low hanging fruit' at RMN sites

- Inexpensive sensors
- Low maintenance
- Less error prone/require fewer corrections



Equipment

RMN sites:

- At least **one water and air temperature sensor** should be deployed at each site



Many different
sensor
options!

Simple, inexpensive sensors are being
used at RMN sites

Radiation Shields

In addition to the sensor, you should also have a radiation shield to -

- **Prevent direct solar radiation from hitting the sensors and biasing the readings**
- **Serve as a protective housing**



Keep sun & sediment off...

Examples of radiation shields for
water temperature sensors



Several holes are drilled into the canister to make it neutrally buoyant and to facilitate water circulation.

Air Temperature - challenging!

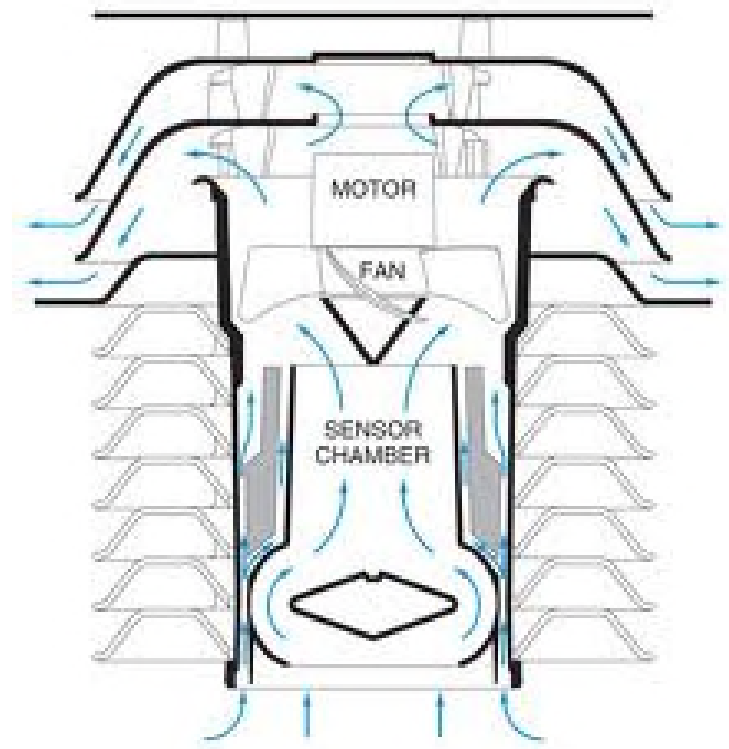
Unbiased measurements can be difficult to obtain.

Most effective radiation shields are **mechanically aspirated**.

Small fan located within the shield that **maintains air flow in low wind conditions**.

Require power which makes them unsuitable for remote deployment.

Can also be expensive.



Passive Air Temperature Radiation Shields

Many RMN partners have made their own **low-cost passive shields**.

Zack Holden (USFS) has documents and a YouTube video with **instructions on how to construct the shield** that he designed and has successfully used at thousands of sites



Short communication

Design and evaluation of an inexpensive radiation shield for monitoring surface air temperatures

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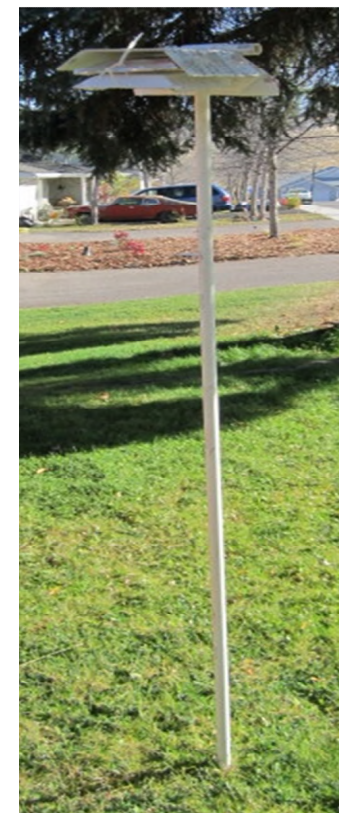
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Free-standing



Sensor Placement

Depends on objectives of your study and site-specific considerations.

At RMN sites

- Sensors should be deployed in the **same locations over time**
- Air and water temperature sensors should be located **in close proximity (if possible)**
- The location should be **representative** of the characteristics of the reach from which the biological data are being collected



Water temperature sensors *should be* placed in locations that are:

- **Well-mixed** horizontally and vertically
- **Of sufficient depth** to keep the sensor submerged year round
- **Stable, safely accessible** during different flow conditions, and **easy to relocate**
- **Protected** from physical impacts associated with high flow events (e.g., the downstream side of a large landmark rock or log; this also helps to hide it)
- **Low human activity** to reduce vandalism and accidental snagging



Water temperature sensors *should NOT be* placed in locations that:

- Are areas of **high use, visibility, or fishing access**
- Have **heavy beaver activity**
- Have **backwater pools, eddies, or standing water** that might stratify during low flow conditions
- Are **influenced by localized warm or cool water sources**, such as
 - a tributary confluence
 - an impoundment (including beaver ponds)
 - a lake outlet
 - point-source discharges
- Have a **very high gradient** ($>7\%$). Sensor retention rates are inversely related with slope (Isaak et al. 2013).



Depth

- Should be placed **approximately 6 inches above the stream bottom** (per Schuett-Hames et al. 1999).
- What about in **small, shallow streams**?
 - You may have no choice but to place a **sensor near the stream bottom** to ensure that it remains submerged during low flows. If this happens, note on the field form because:
 - Measurements could be influenced by **groundwater and subsurface flow**;
 - Sensors on or near the streambed are **more susceptible to burial by moving substrates** (sensors should never be intentionally buried).



Placement of air temperature sensors at RMN sites

If the **riparian zone is forested**, mount the air temperature sensor to the tree that is:

- 1) nearest the water temperature sensor; and**
- 2) large enough to support the radiation shield and sensor** (ideally >12 inches (0.305 meters) in diameter).

For our purposes, **trees** generally make the best attachment points because they **provide stability, some degree of shade, and can help hide the sensor** from potential vandals.

If a suitable tree is present, attach the radiation shield and sensor to its **north side, out of direct sunlight** (see 'Best Practices' report for a simple process for doing this).

Placement of air temperature sensors at RMN sites

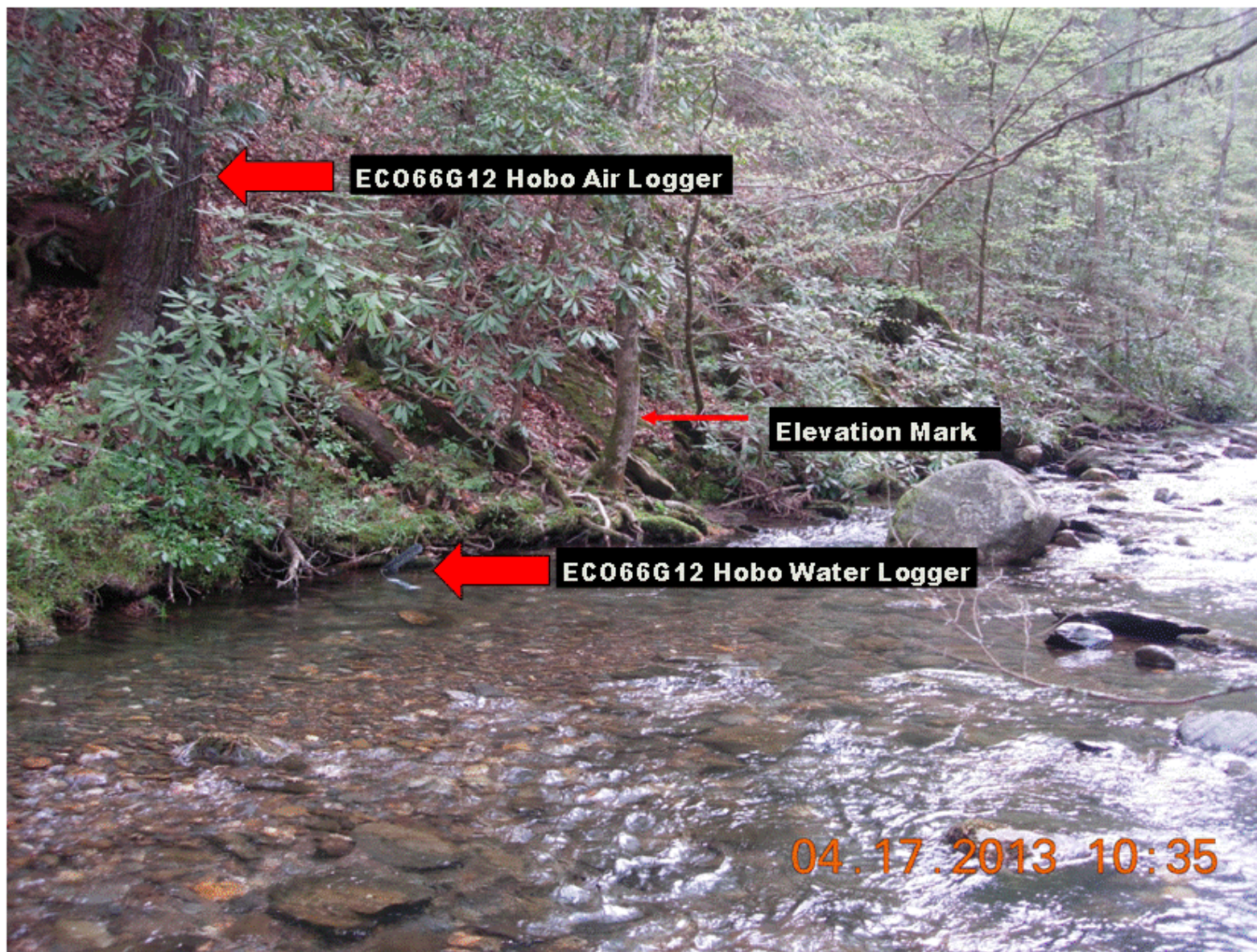
To be consistent with typical meteorological observations, **air sensors should be placed at a height of approximately 4-6 feet off the ground.**

Try to minimize the amount of other vegetation near the sensor.

Why? The ground, vegetation and other objects can create radiation microenvironments that bias readings.



Example of air and water sensor placement



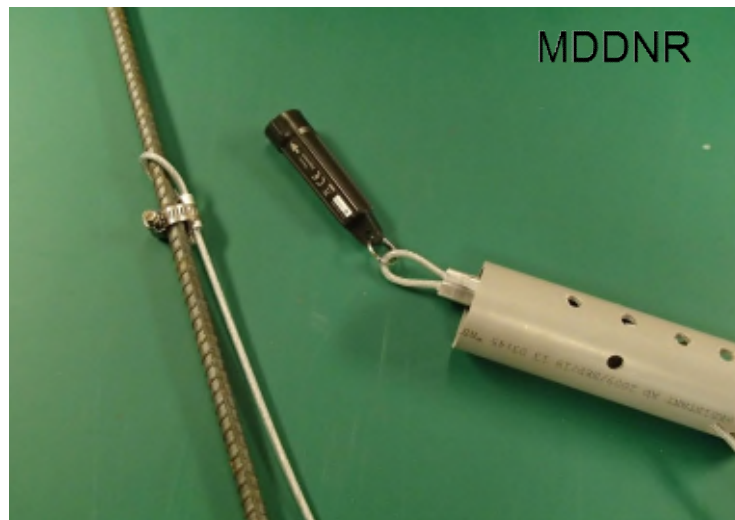
Installation techniques for water temperature sensors

In the report, we cover the following techniques:

- **Underwater epoxy method** (Isaak et al. 2013)
- Attaching sensors to **stable instream structures** or **rebar**

Other techniques are being used as well.

Site-specific conditions will dictate which installation technique is most appropriate.

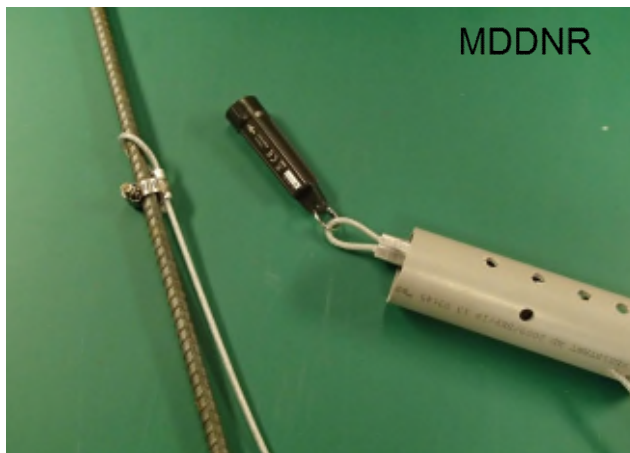


Attaching sensors to stable instream structures

If there is a **large rock or boulder, root, woody debris** or other stable instream structure, you can attach the sensor and housing to the structure using **heavy-duty materials** like plastic-coated **galvanized steel cable/wire rope, metal clamps, and heavy-duty cable ties**.

If you think the structure might move during high flow events, consider cabling or chaining the structure to an object on the nearest bank (or to another stable instream structure).

Use heavy-duty materials!



Cable and rebar set-up for a large stream in Maryland

If conditions permit, **attach cable ties at two points**.



Rebar installations

If a site **lacks stable instream structures** and the stream bottom is such that a metal stake can be driven into it, drive **rebar** (generally 2–4 feet) into the streambed, deep enough to stay in place during high stream flow events. Consider using **bent rebar** – it is **more secure** and poses **less safety risk** for people wading in the stream.

The sensor and its protective housing are attached to the rebar via **heavy-duty materials** like **metal clamps**, **heavy-duty cable ties** and **galvanized steel cable/wire rope**.



Rebar installations



Rebar and
metal hose
clamp

Small stream in Shenandoah
National Park, VA (Craig
Snyder, USGS).



Bent rebar is
more
secure and
poses **less**
safety risk
to people
wading in
the stream

Design by Christopher Harbourt,
Champaign, IL.

www.waterborne-env.com

Underwater epoxy installations

Dan Isaak, Dona Horan, Sherry Wollrab

Fisheries Biologists, USDA Forest Service, Rocky Mountain Research Station



Isaak et al. 2013. A simple protocol using underwater epoxy to install annual temperature monitoring sites in rivers and streams. USFS General Technical Report, 314.

YouTube video:

<http://www.youtube.com/watch?v=vaYaycwfmXs&feature=youtu.be>

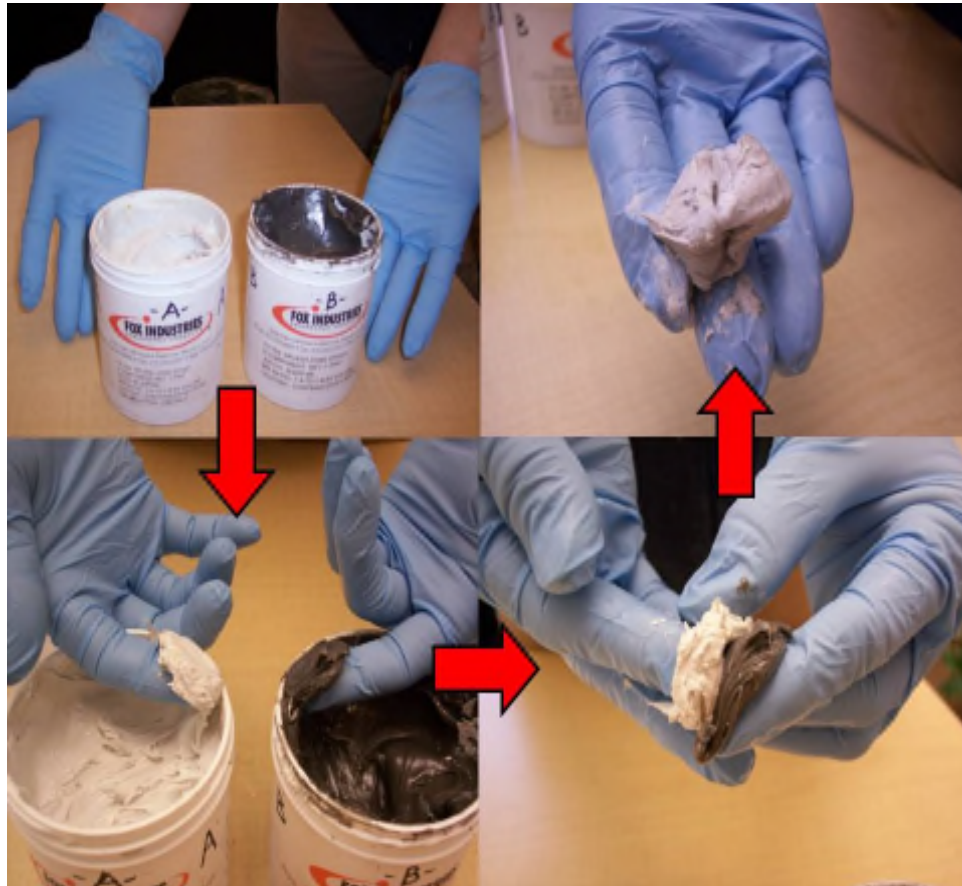
Underwater epoxy installations

Use epoxy to attach the sensor to the structure



Equipment: (a) two-part FX-764 epoxy from Fox Industries, (b) PVC solar shield, (c) temperature sensor, (d) cable ties, (e) plumber's tape, (f) rubber gloves, (g) plastic viewing box, (h) wire brush, and (i) metal forestry tree tag (Isaak and Horan 2013)

Underwater epoxy installations



Underwater epoxy installations

Select a suitable anchor point:

- **Protrudes ≥ 1 foot above the water surface at low flows**
- **Wide enough to protect sensor** from moving rocks/debris during floods
- **Flat attachment site on downstream side** and relatively deep water with flow
- **Small substrate on downstream side** and 8 inches of **space for shuttle attachment**



Examples of good attachment points. Arrows point to the solar shield containing a sensor; circles highlight metal forestry tags epoxied above the sensor to monument the site (photos from Isaak et al. 2013).

Other installation techniques are being used as well...

CT DEEP has used window weights, angle irons, and tethering to secure structures



Photos
provided by
CT DEEP

Figure 12. (A) TidbiT® tethered to PVC housing with tie wraps and fastened to window weights with parachute cord. (B) and (C) HOBO® attached to PVC housing with tie wraps and angle iron weight.

Acknowledgments

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Plus other RMN partners and collaborators...

QUESTIONS? COMMENTS?



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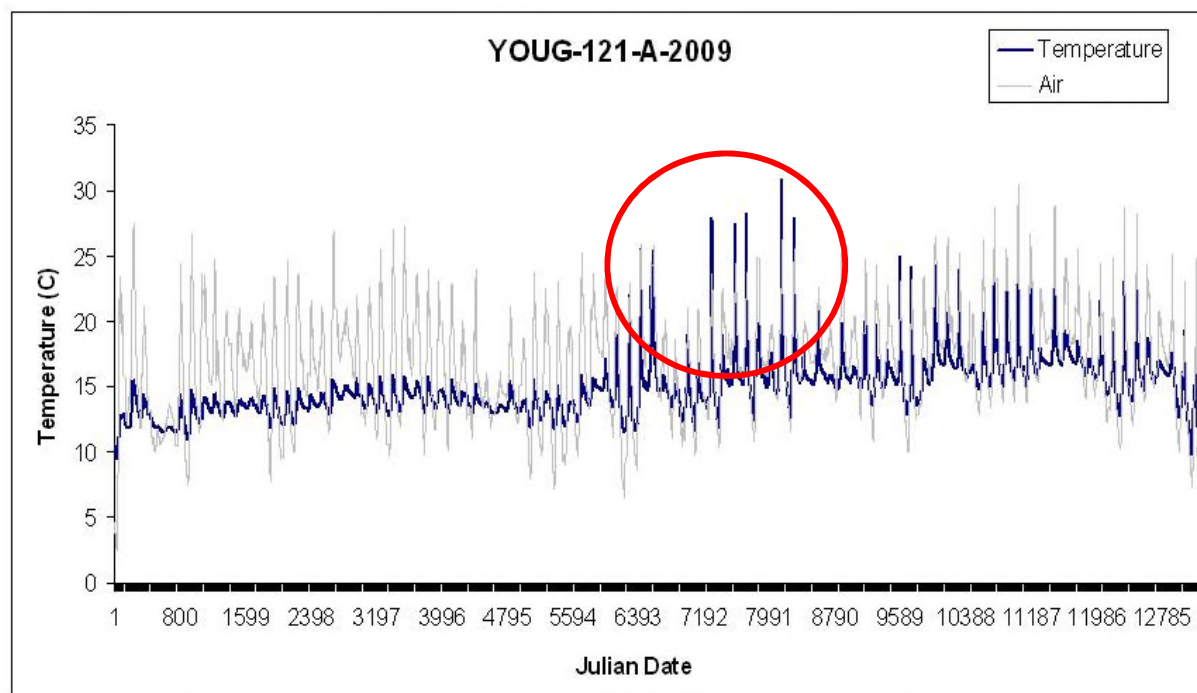
Why collect air temperature?

To gain a better understanding of the ‘**thermal sensitivity**’ of **streams** (e.g., how does the air-water temperature relationship vary across sites from different **regions**, **size** classes, gradients, with differing levels of **groundwater influence**, etc.).

Air temperature data, which are **more readily available** than stream temperature data, can be used to **model (historic and future) stream temperature**, and to **improve or validate models** that predict stream temperature.

Why collect air temperature?

Help **determine if water temperature sensors are dewatered** during their deployment, and over what specific time periods.



Graph provided by MDDNR